



# Presence of SARS-CoV-2 on the Surface of Fruits and Vegetables

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**ABSTRACT:** There is no information about whether the SARS-CoV-2 virus is present on the surface of fruits and vegetables obtained from grocery stores. The goal of this study is to determine if SARS-CoV-2 was present on the surfaces of produce in grocery stores in the Philadelphia metropolitan area during the peak pandemic period. Produce from 10 stores was swabbed and then analyzed for the presence of the virus. Of the 140 fruits and vegetables tested, only one fruit sample contained SARS-CoV-2 on its surface. The results indicate that the spread of the virus through contact with produce is highly unlikely.

**KEYWORDS:** *fomite, surface, coronavirus, fruits, vegetables, SARS-CoV-2*

Current guidance from the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) states that while the spread of SARS-CoV-2 is possible through the touching and handling of food that has the virus on its surface, it may not be the main route for spreading.<sup>1,2</sup> Furthermore, the CDC guidelines suggest that washing fruits and vegetables is not warranted to remove SARS-CoV-2.<sup>1</sup> The suggestion originates from the lack of studies investigating the presence of SARS-CoV-2 on the surface of fruits and vegetables. In our study, we looked for the presence of the virus on produce across grocery stores in Philadelphia and neighboring counties across Pennsylvania, New Jersey, and Delaware. The goal of the study was to confirm if indeed SARS-CoV-2 is present on the surface of fruits and vegetables.

Ten grocery stores were selected across three states and six counties. Three of the stores selected were in Philadelphia. High-touch open fruits and vegetables (apples, asparagus, avocados, bananas, broccoli, carrots, garlic, grapes, lemons, lettuce, onions, pears, potatoes, and tomatoes) were purchased on Sunday, December 6, 2020, between peak times of 10:00 a.m. and 6:00 p.m. All of the counties had high levels of community spread of the virus on the day of sampling. At least five individual fruits and vegetables were purchased from each store. None of the items purchased were prepackaged. In three stores, carrots were not available and were substituted with either turnips or beets. In one store, lettuce was not available and was substituted with kale. For each fruit or vegetable from a given store, five individual items were selected and each of them was swabbed at five separate areas using the same swab from ESK Environmental Sampling Kits from Puritan Medical Products. Grocery bags from individual stores served as controls. Swabs were analyzed for the presence of SARS-CoV-2 by Assured Bio Laboratories.

Individual swabs were suspended in a guanidine hydrochloride lysis buffer. After lysis, subsamples from each type of produce were pooled into groups of five (i.e., two groups of five for each type of produce). Sample remainders were stored

at  $-80^{\circ}\text{C}$  for subsequent analysis, if required. Pooled samples were bound to silica columns with carrier RNA and the positive internal control (rpp30). Columns were washed with ethanol-based buffers and eluted in polymerase chain reaction (PCR) grade water. The RNA extracts were reverse transcribed using the High-Capacity cDNA Reverse Transcription Kit (Applied Biosystems, Foster City, CA). The CDC's 2019-nCoV\_N1 and 2019-nCoV\_N2 quantitative PCR assays were used for the detection of SARS-CoV-2 genetic material in the RNA extract of the samples using PerfeCTa FastMix II (QuantaBio, Beverly, MA). Simultaneous detection of both assays was required to report a positive result. Samples were spiked with ribonuclease P protein subunit p30 (rpp30) to act as an internal positive control to detect inhibition and potential false negatives. The N2 assay was used for quantification as it has been found to be more sensitive than the N1 assay.<sup>3</sup> Results were quantified to genomic equivalents by comparing experimental values to standard curves generated following the exact same protocol and using the same reagents as the samples using reference stocks from the Biodefense and Emerging Infections Research Resources Repository (BEI Resources NR-52358). In the event of detection on any of the pooled samples, the retained sample remainders were analyzed individually and quantified as described above.

Of the 140 fruits and vegetables tested from 10 stores, 10 samples (five carrots and five grapes) could not be included in the analysis of the results due to complete inhibition of the PCR assay. We believe that this could be because of the presence of certain pesticides or other chemicals present on the surface of the produce. Viral analysis of the swab samples from the fruits and vegetables obtained from nine stores showed no

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presence of the virus on the surface. However, SARS-CoV-2 was confirmed on the surface of only one produce sample (apple) from a single store at a concentration of 11 genomic equivalents per swab. No control samples showed the presence of the virus.  $\chi^2$  analysis of the results shows that the observation of SARS-CoV-2 on the surface of one sample is statistically insignificant ( $p > 0.05$ ).

Previous studies about the presence of SARS-CoV-2 on surfaces in a real-world setting have shown a high prevalence.<sup>4–7</sup> In contrast, our research shows that there is a 1/130 chance of finding the virus on the surface of fruits and vegetables in grocery stores. The results support the data reported by Telang et al.,<sup>8</sup> who showed that even after fruits and vegetables are handled by COVID-19 patients, within 1 h of storage in areas with a free flow of natural air, no SARS-CoV-2 is detected on the surface of the produce. On the basis of the data, we believe the guidelines of regulatory agencies are adequate and fruits and vegetables in grocery stores are not the major source of the spread of the virus in the community. Nevertheless, there is a small chance that a person can expose themselves to SARS-CoV-2 by touching the surfaces of fruits and vegetables. Considering this, we recommend using hand sanitizer or washing hands after handling produce.

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### Notes

The authors declare no competing financial interest.

## DEDICATION

This communication is dedicated to Dr. Frantisek Nerud, Academy of Sciences of Czech Republic, a mentor and a friend.

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